

CLAIMS

What is claimed is:

1. A circuit manufacturing method comprising:

5 forming an opening in a first side of a semiconductor substrate, with a plurality of conductive layers overlaying each other in the opening, the conductive layers including a first conductive layer and a second conductive layer overlaying the first conductive layer such that the first and second conductive layers either (i) are separated by an insulating layer in the opening, or (ii) form a P-N junction in the opening, or (iii) form a Schottky junction in the opening;

10 removing material from a second side of the semiconductor substrate to expose the second conductive layer in the opening on the second side of the substrate.

2. The method of Claim 1 wherein the first and second conductive layers are
15 separated by an insulating layer in the opening.

3. The method of Claim 1 wherein the first conductive layer in the opening shields the substrate from an electromagnetic field created by an AC signal carried by the second conductive layer in the opening during operation of the circuit.

20 4. The method of Claim 1 further comprising, before forming the first conductive layer, forming an insulating layer in the opening to insulate the first conductive layer from the substrate in the opening.

25 5. The method of Claim 1 wherein the first conductive layer comprises a doped region of the semiconductor substrate occupying at least a portion of the sidewalls of the opening.

30 6. The method of Claim 1 wherein the semiconductor substrate is processed to provide an integrated circuit, and an exposed portion of the second conductive layer serves as a contact pad of the integrated circuit.

7. The method of Claim 1 wherein the semiconductor substrate is processed to provide an integrated circuit, and an exposed portion of the second conductive layer serves as an input, output, or input/output terminal of the integrated circuit.

5 8. The method of Claim 1 wherein removing material from the second side comprises mechanical removal of the material, and wherein the second conductive layer is exposed in the opening on the second side during the mechanical removal of the material.

10 9. The method of Claim 8 wherein mechanical removal of the material comprises chemical mechanical polishing.

10. The method of Claim 1 wherein the conductive layers include a third conductive layer overlaying the second conductive layer and filling the opening; and
15 wherein removal of the material from the second side comprises mechanical removal of the material, and wherein the third conductive layer is exposed in the opening on the second side during the mechanical removal of the material.

20 11. The method of Claim 10 wherein the mechanical removal of the material is followed by an etch of material on the second side, and wherein at least one of the second and third conductive layers protrudes from the opening on the second side after the etch.

25 12. The method of Claim 1 wherein after the removing of the material, the first and second conductive layers are exposed in the opening on the second side; and wherein the method further comprises, after said removing of the material, processing the second side with a chemical reagent or reagents that react with the semiconductor substrate and/or the first conductive layer and/or the second conductive layer to form an insulator.

30 13. A circuit structure comprising a semiconductor substrate, an opening passing through the substrate between a first side of the substrate and a second side of the substrate, and a plurality of conductive layers which overlay sidewalls of the opening, wherein the conductive layers include a first conductive layer and a second conductive

layer such that the first and second conductive layers either (i) are separated by an insulating layer in the opening, or (ii) form a P-N junction in the opening, or (iii) form a Schottky junction in the opening;

5 wherein the second conductive layer is exposed on the second side of the opening, and the first conductive layer surrounds the second conductive layer in the opening.

14. The circuit structure of Claim 13 wherein the first and second conductive layers are separated by an insulating layer in the opening.

10 15. The circuit structure of Claim 13 wherein an exposed portion of the second conductive layer on the second side provides an input, output, or input/output terminal of an integrated circuit.

15 16. The circuit structure of Claim 13 further comprising an insulator insulating the first conductive layer from the sidewalls of the opening.

17. The circuit structure of Claim 13 wherein the conductive layers include one or more conductive layers surrounding the first conductive layer in the opening and insulated from the first conductive layer in the opening.

20 18. The structure of Claim 13 wherein the first conductive layer comprises a doped region of the semiconductor substrate on the sidewalls of the opening.

25 19. The structure of Claim 13 wherein the conductive layers include a third conductive layer formed over the first and second conductive layers and filling the opening, wherein the third conductive layer is exposed on the second side of the opening.

20 20. A circuit manufacturing method comprising:
 forming an opening in a first side of a semiconductor substrate;
30 forming at least three conductive layers overlaying each other in the opening, such that each two consecutive conductive layers either (i) are separated by an insulating layer in the opening, or (ii) form a P-N junction in the opening, or (iii) form a Schottky junction in the opening;

removing material from a second side of the semiconductor substrate to expose at least one of said conductive layers in the opening on the second side of the substrate.

21. The method of Claim 20 wherein all of said conductive layers are metal
5 layers which are separated from each other by insulating layers in the opening.

22. The method of Claim 20 wherein at least two of said conductive layers are connected through a permanent or programmable connection outside of the opening.

10 23. A circuit structure comprising:
a semiconductor substrate, and an opening passing through the substrate between a first side of the substrate and a second side of the substrate;
at least three conductive layers overlying each other in the opening, such that each two adjacent conductive layers either (i) form a P-N junction in the opening, or (ii) form
15 a Schottky junction in the opening, or (iii) are separated by an insulating layer in the opening;
wherein one of said conductive layers is exposed on the second side.

20 24. The circuit structure of Claim 23 wherein an exposed portion of said one of said conductive layers on the second side provides an input, output, or input/output terminal of an integrated circuit.

25 25. The circuit structure of Claim 24 wherein only one of said conductive layers is exposed on the second side.

26. The circuit structure of Claim 25 wherein said conductive layers are separated from each other by insulating layers in the opening.

27. A circuit manufacturing method comprising:
30 forming an opening in a first side of a semiconductor substrate;
forming a plurality of conductive layers overlaying each other in the opening, the conductive layers including a first conductive layer and a second conductive layer overlaying the first conductive layer such that the first and second conductive layers either (i) form a P-N junction, or (ii) form a Schottky diode junction;

removing material from a second side of the semiconductor substrate to expose at least one of the first and second conductive layers on the second side.

28. A circuit structure comprising:

5 a semiconductor substrate, and an opening passing through the substrate between a first side of the substrate and a second side of the substrate;

a plurality of conductive layers overlaying each other in the opening, the conductive layers including first and second conductive layers which either (i) form a P-N junction in the opening, or (ii) form a Schottky junction in the opening;

10 wherein at least one of the first and second conductive layers is exposed on the second side.

29. The circuit structure of Claim 28 wherein an exposed portion of one of the first and second conductive layers on the second side provides an input, output, or
15 input/output terminal of an integrated circuit.